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ADDENDUM TO TECHNICAL MEMORANDUM NO 2

HUMAN HEALTH RISK ASSESSMENT
EXPOSURE SCENARIOS
OPERABLE UNIT 3

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

ENVIRONMENTAL RESTORATION PROGRAM

MARCH 10, 1995

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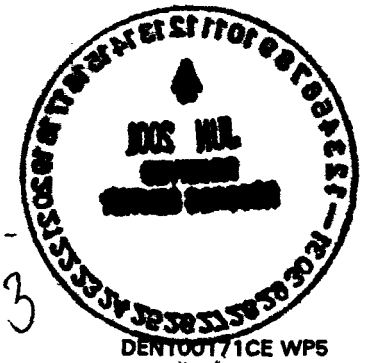
Figures



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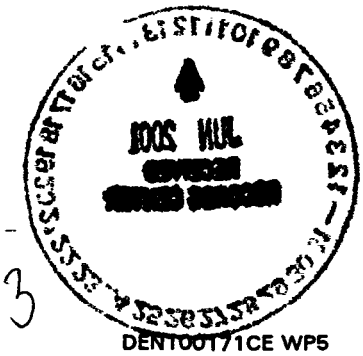

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SECTION 1 0
INTRODUCTION

This addendum to the Exposure Scenarios Technical Memorandum No 2 (TM 2) for the Human Health Risk Assessment (HHRA) at Rocky Flats Environmental Technology Site (the Site) Operable Unit No 3 (OU 3) supplements the April 1993 draft of TM 2 (DOE, 1993a) Revisions have been made based on comments from the Environmental Protection Agency Region VIII (EPA) and the Colorado Department of Public Health and Environment (CDPHE) and new information including that from the process of identifying Chemicals of Concern (COCs) (DOE, 1994a) and Areas of Concern (AOCs) (DOE 1994b) Responses to EPA and CDPHE comments on the draft version of TM 2 are included as an attachment to this addendum

This addendum identifies potentially complete exposure pathways land uses, and human receptors at OU 3 and presents the exposure parameters for estimating central tendency (CT) and reasonable maximum exposures (RME) This addendum in conjunction with the draft Exposure Scenarios Technical Memorandum (April 1993 TM 2) meets the requirements of Section VII D of the Interagency Agreement (IAG 1991)

SECTION 2 0
CHRONOLOGY OF THE EVALUATION OF EXPOSURE SCENARIOS AT OU 3

The identification of exposure scenarios has evolved through several evaluation phases. The first evaluation of the exposure scenarios in OU 3 is found in the Past Remedy Risk Assessment Report (DOE, 1991a) and in the Historical Information Summary and Preliminary Risk Assessment (DOE, 1991b) The OU 3 RFI/RI Work Plan (DOE, 1992) identifies several priority pathways based on these two reports and other available information on OU 3 The April 1993 TM 2 further refined the exposure scenarios using more recent sampling results, land-use, and demographics information (DOE, 1993a) Finally, EPA, CDPHE, and DOE introduced several new evaluation processes to focus on those data contributing significantly to risk. These processes include the COCs selection process and the identification of AOCs (CDPHE/EPA/DOE, 1994) Also, information regarding land use in OU 3 has been updated.

2 1 1991 OU 3 RISK ASSESSMENT REPORTS

Two risk assessment reports, the Past Remedy Risk Assessment Report (DOE, 1991a) and the Historical Information Summary and Preliminary Risk Assessment (DOE, 1991b), both IAG deliverables, were released to the public in 1991 The primary objectives of these reports were to evaluate known data associated with the surface soils (IHSS 199) and the reservoirs (IHSSs 200, 201, and 202) Using the available data, a qualitative risk assessment was performed and a generic quantitative risk assessment was also included. The most significant potential exposure pathway identified was resuspension of particulates from surface soil into the atmosphere. However, the reports concluded the accumulated data did not meet necessary quality control standards to support a quantitative baseline risk assessment (BRA) for use in an RFI/RI study conducted under the IAG To collect the necessary data, the RFI/RI Work Plan (DOE, 1992) was developed.

2 2 OU 3 RFI/RI WORK PLAN PRIORITY EXPOSURE PATHWAYS

The RFI/RI Work Plan for Operable Unit 3 (DOE, 1992) presented conceptual exposure pathway models for IHSSs 199 (Soils) 200 (Great Western Reservoir), 201 (Standley Lake) and 202 (Mower Reservoir) The primary purpose of the conceptual models was to identify potential exposure pathways by which existing and future populations may be exposed to contaminants from the IHSSs

The conceptual models presented in the work plan provide an overview of the potential exposure pathways and a contaminant source and transport characterization for each environmental medium Some of these pathways have a higher potential for occurrence and may have greater adverse risk impacts than others Exposure pathways included in the conceptual model were identified by evaluating potential sources of contaminants and the fate and mobility of the contaminant in each potential source and transport medium

The primary exposure pathway identified in the work plan for IHSS 199, from a human health risk standpoint, was inhalation of soil dispersed to air through wind erosion The secondary pathway identified for IHSS 199 was direct ingestion of soil The remaining pathways were believed to constitute a negligible risk to human health but were addressed in the work plan to confirm the conceptual model

The primary pathway identified in the work plan for IHSSs 200, 201, and 202, from a human health risk standpoint, was inhalation of reservoir/stream sediments dispersed to air through resuspension of fugitive dust. The secondary pathways for IHSSs 200, 201, and 202 were direct ingestion of sediments and surface water The remaining pathways were believed to constitute a negligible risk to human health but were addressed in the work plan to confirm the conceptual model

2.3 EXPOSURE SCENARIOS TM 2

Data from the RFI/RI sampling program (conducted in 1992) were used to confirm that the potential exposure pathways presented in the work plan could exist and could be complete An exposure

scenarios technical memorandum, TM 2, (DOE, 1993a), was released as a draft in April 1993 for EPA and CDPHE review The scenarios presented in the draft TM2 have been revised based on information presented in Technical Memorandum No 4 (TM 4) Identification of Chemicals of Concern (DOE, 1994a), the CDPHE Conservative Screen Letter Report (DOE, 1994b), and EPA and CDPHE comments on the draft version of TM 2

2.4 LAND USE UPDATE

This section contains information that updates Section 3.0, Land Use in the OU 3 Study Area, of the draft version of TM 2, based on new information regarding the future land use within OU 3 The new information impacts potential exposure scenarios for IHSS 199 surface soils and IHSS 200 (Great Western Reservoir)

Currently, land use in significant portions of OU 3 is controlled through zoning limitations and land use restrictions included in the existing deeds of ownership All locations identified as AOCs in the CDPHE Conservative Screen Letter Report (DOE, 1994 b) are within areas currently owned by either the City of Broomfield or Jefferson County and are subject to the City and County zoning requirements (Note Parcels D, E, and F on Figure 1 are in the process of being sold to the city of Westminster) In addition, all AOCs are located within areas zoned for open space. The City of Broomfield, through deeds of ownership (Jefferson County, 1964, Jefferson County, 1985a, Jefferson County, 1985b), controls the use of land surrounding Great Western Reservoir (see parcels identified as A, B, and C on Figure 1) A small portion of parcel C, located near the northeast portion of Great Western Reservoir, is zoned for Planned Unit Development (PUD) and is not owned by the City of Broomfield. According to the City of Broomfield (Oglesby, 1995), any uses of this land would have to be compatible with the overall open space planning and zoning requirements of the parcel and would require the submittal of development plans, public hearings and approval by the Broomfield City Council Additionally, as indicated on Figure 1, Jefferson County has similar legal authority over the parcels identified as D and E which includes the Jefferson County Remedy acres (Jefferson County, 1985c; Jefferson County, 1985d)

The City of Broomfield and Jefferson County are closely involved in the current and future land use issues associated with OU 3 This is evidenced by the municipalities' purchase in 1985 of parcels

A, B, D and E, and their placement of deed restrictions on these lands for the expressed purpose of limiting potential exposure to plutonium (Jefferson County 1985a, Jefferson County, 1985b, Jefferson County, 1985c, Jefferson County, 1985d)

Parcel C has been owned by the City of Broomfield since 1964 and, with the exception of the area zoned for PUD is zoned for open space use Parcel C does not have specific deed restrictions because the City of Broomfield 1) is aware of the existence of plutonium contamination, 2) has had control of the land since before plutonium issues associated with the Site were known, and 3) has historically maintained effective control by limiting development in that area

Considering the municipalities zoning and deed restriction actions previously described it is not likely that either the City of Broomfield or Jefferson County will change their ownership rights or plans for open space use of these lands Such changes would require formal legal actions because of zoning requirements and land use restrictions embodied in the deeds The deeds for parcels A, B D, and E (Jefferson County, 1985a, Jefferson County, 1985b, Jefferson County, 1985c, Jefferson County, 1985d) reveal that future use of these parcels is officially restricted to open space applications such as recreational, and similar uses compatible with the open space planning and zoning theme According to the deeds, these land use restrictions "shall be perpetual and shall run with the land " In summary, it is apparent that the City of Broomfield and Jefferson County have legal authority and have taken responsible stewardship of the areas within OU generally regarded as being affected by plutonium historically released from the Site

An additional consideration with respect to the future use of the lands identified on Figure 1 is the recent United States Department of the Interior, Fish and Wildlife Service (USFWS) biological opinion regarding land within parcels D and E (Carlson, 1994) As expressed in their opinion, USFWS recommends that the prairie dog habitat on Jefferson County s property (roughly parcels D and E) is essential and should be "preserved and managed to the fullest extent possible" in observance of its role in the ecosystem relative to the bald eagle (an endangered species) as well as the peregrine falcon (Carlson, 1994) Thus any future land use activities that affect the prairie dog population would be incompatible with the USFWS recommendation to protect the bald eagle and peregrine falcon

Finally, there is a land use issue involving Great Western Reservoir By 1997, the City of Broomfield may shift from using Great Western Reservoir as its water source to using Carter Lake and water purchased from the Denver Water Board. Due to the value of the water in Great Western Reservoir and the expense to develop the reservoir for other purposes, the most likely future scenario for Great Western Reservoir is undrained. However, the future of Great Western Reservoir is uncertain Although unlikely, the possibility exists that the reservoir may be drained, the dam and water treatment plan abandoned, and the land employed for an alternative use consistent with the zoning requirements. The potential land uses for a drained Great Western Reservoir will also be addressed in the HHRA.

SECTION 3 0
ASSESSMENT OF EXPOSURE AND RISK

The assessment of exposure and risk in the HHRA involves a series of data evaluation steps (Figure 2)

(1) Comparison of the OU 3 data to background concentrations (DOE, 1994a)–Gilberts Statistics Toolbox/Background Comparison

(2) Identification of the COCs (EPA COC Selection Process) and AOCs (CDPHE Conservative Screen Process) (DOE 1994a, DOE, 1994b)

(3) Identification of the exposure areas in the AOCs–Exposure Assessment

(4) Identification of the potential exposure scenarios for the exposure areas–Exposure Assessment

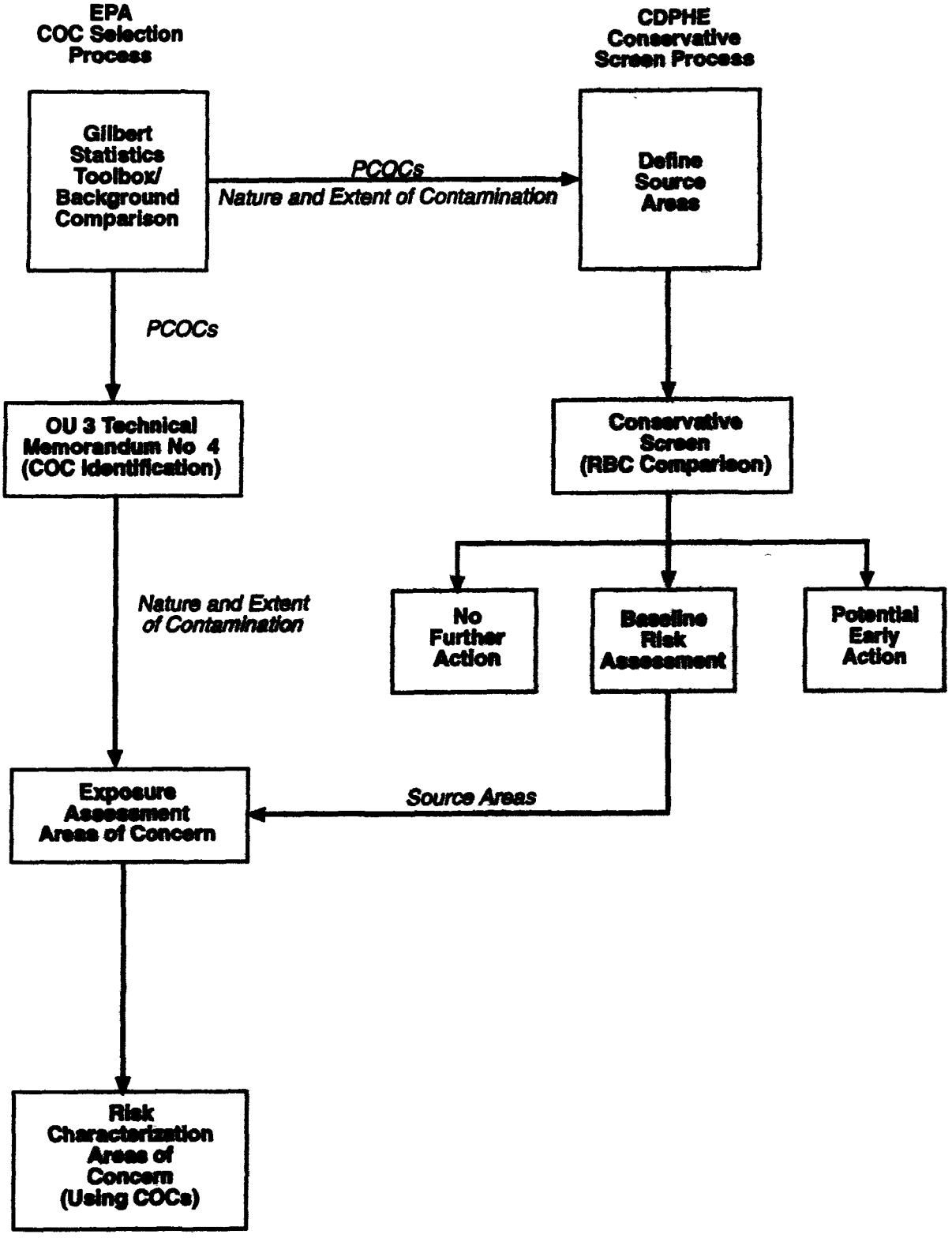
(5) Calculation exposure point concentrations–Exposure Assessment

(6) Calculation of risk estimates–Risk Characterization

Steps 1 and 2 are described in TM 4 (DOE, 1994a) and the CDPHE Conservative Screen Letter Report (DOE 1994b) respectively and are summarized below in Sections 3 1 and 3.2 of this addendum The identification of exposure areas, Step 3, is included in Section 4 of this addendum Steps 5 and 6, calculation of exposure point concentrations and risk estimates, will be presented in the OU 3 HHRA report.

3 1 CHEMICALS OF CONCERN

For the OU 3 HHRA, exposures will be quantitatively assessed for COCs identified in TM 4 (DOE 1994a) Surface soil, sediment, surface water, and groundwater samples were collected during the field investigation to address the pathways identified in the OU 3 conceptual models COCs were



CDPHE = Colorado Department of Public Health and Environment
COC = Chemical of Concern
EPA = U S Environmental Protection Agency
PCOC = Potential Chemical of Concern

Figure 2
COC/Area of Concern
Identification Processes

Source CDPHE/EPA/DOE 1994

Table 3-1
OU 3 Chemicals of Concern[a]

IHSS	Surface Soil	Surface Sediment	Subsurface Sediment	Surface Water	Groundwater
199 Contamination of Soils	$^{239/240}Pu$ ^{241}Am	NA	NA	NA	NA
200 Great Western Reservoir	NA	$^{239/240}Pu$	-	-	-
201 Standley Lake	NA		-	-	-
202 Mower Reservoir	NA		-	-	-

Notes

$^{239/240}Pu$ = Plutonium-239/240

^{241}Am = Americium-241

NA = not applicable (IHSS 199 includes surface soil only IHSSs 200-202 include surface water sediment and groundwater only)

\- = No COCs were identified in TM 4(see DOE 1994a for a presentation of the COC identification process)

[a]Identification of Chemicals of Concern Technical Memoradnum No 4 for OU 3 (DOE 1994a)

identified using data from the investigation (DOE, 1994a) COCs are chemicals that, based on concentration and toxicity, contribute significantly to risks (EPA, 1989a) The COCs were selected based on guidance agreed upon by EPA, CDPHE, and DOE which is based on Risk Assessment Guidance for Superfund (EPA, 1989), the Interagency Agreement (IAG, 1991), and site-specific guidance (CDPHE/EPA, 1993; DOE, 1993b, CDPHE/EPA/DOE, 1994, and EPA, 1994a)

Plutonium-239/240 ($^{239/240}$Pu) and Americium-241 (^{241}Am) were identified as COCs in IHSS 199 surface soils along with $^{239/240}$Pu in surface sediments of IHSS 200, Great Western Reservoir (Table 3-1) No other chemicals were identified as COCs in OU 3 Exposure scenarios are not presented for the following media without COCs

- IHSS 200, Great Western Reservoir subsurface sediments, surface water, and groundwater

- IHSS 201, Standley Lake surface and subsurface sediments, surface water, and groundwater

- IHSS 202, Mower Reservoir surface and subsurface sediments and surface water

3.2 AREAS OF CONCERN

For risk assessments conducted at the Site, exposures will be assessed in separate AOCs (CDPHE/EPA/DOE, 1994). AOCs were identified within OU 3 by following the CDPHE Conservative Screen process, as described in the CDPHE Conservative Screen Letter Report (DOE, 1994b) AOCs are defined as one or several areas with concentrations above background (Source Areas) grouped in spatial proximity whose maximum concentrations exceed a risk-based concentration (i e , a concentration that represents a 1×10^{-6} risk). Three parcels of land in IHSS 199 (Soils Contamination) and the surface sediments, assuming the reservoir is drained, in IHSS 200 (Great Western Reservoir) were identified as AOCs (see the CDPHE Conservative Screen Letter Report [DOE, 1994b] for a detailed presentation of the results) The risk drivers were $^{239/240}$Pu and ^{241}Am in the soils of the Jefferson County Remedy acres and $^{239/240}$Pu in the sediments of Great Western Reservoir This is consistent with TM 4, which identified $^{239/240}$Pu and ^{241}Am in

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soils and $^{239/240}Pu$ in Great Western Reservoir sediments as COCs (DOE, 1994a) Using the CDPHE protocol no AOCs were identified in the remaining IHSSs

SECTION 4 0
EXPOSURE SCENARIOS

Exposure scenarios have been refined from TM 2 based on the COCs and the identified AOCs for the following media

- IHSS 199, Soils Contamination surface soils (Section 4 1)
- IHSS 200, Great Western Reservoir surface sediments assuming Great Western Reservoir is drained (Section 4 2)

The components of the exposure scenarios includes

- Identification of current land uses and characterization of future land use scenarios (Section 2 4)

- Identification of potential receptors based on current and future land use scenarios (Sections 4 1 and 4 2)

- Refinement of the conceptual site model. The conceptual site model for OU 3 was first included in the Work Plan (DOE, 1992), then updated in TM 2, and has been further modified to reflect the exposure pathways presented in this addendum (Figure 3)

- Identification of exposure areas for the AOCs

- Identification of exposure parameter values to be used in estimating the central tendency (CT) exposure and the reasonable maximum exposure (RME) at OU 3

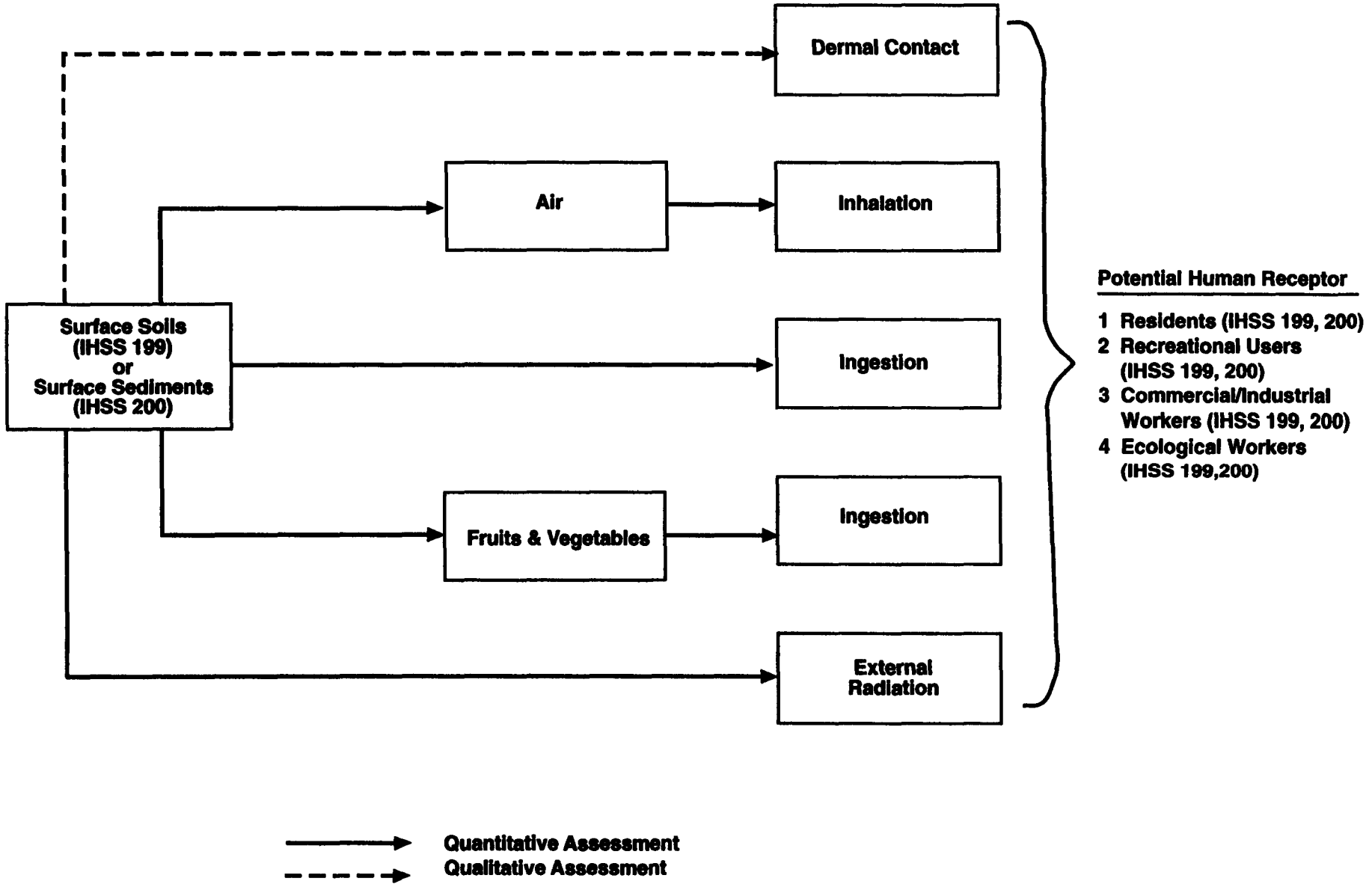

Figure 3
CONCEPTUAL SITE MODEL
POTENTIAL EXPOSURE PATHS
IHSSs 199 AND 200
OU3

The potential land uses and associated exposure pathways have been identified for OU 3 based on COCs and AOCs

Residential Land Use (IHSSs 199 and 200)

- Ingestion of surface soil/surface sediment
- Inhalation of particulates
- Dermal contact with surface soil/surface sediment
- External radiation
- Ingestion of fruits and leafy vegetables

Recreational Land Use (IHSSs 199 and 200)

- Ingestion of surface soil/surface sediment
- Inhalation of particulates
- Dermal contact with surface soil/surface sediment
- External radiation

Ecological Research Land Use (IHSSs 199 and 200)

- Ingestion of surface soil/surface sediment
- Inhalation of particulates
- Dermal contact with surface soil/surface sediment
- External radiation

Commercial/Industrial Land Use (IHSSs and 199 and 200)

- Ingestion of surface soil/surface sediment
- Inhalation of particulates
- Dermal contact with surface soil/surface sediment
- External radiation

The most likely land use for IHSSs 199 and 200 is recreational, and therefore this scenario will be quantitatively evaluated in the HHRA In addition, the land use associated with the most

conservative estimates of risk (i e residential) will also be quantitatively evaluated in the HHRA The commercial/industrial worker and ecological researcher scenarios will not be quantitatively evaluated in the HHRA However it is assumed risks for those two scenarios will be less than risks associated with the residential scenario

4 1 EXPOSURE SCENARIOS FOR IHSS 199 SOILS CONTAMINATION

Plutonium-239/240 and ^{241}Am were identified as COCs in IHSS 199 surface soils (DOE 1994a) Exposure will be assessed at the three areas of concern (AOCs) in IHSS 199 identified just east of Indiana Street in or near the Jefferson County Remedy acres (Figure 4) (DOE 1994b) These AOCs are comprised of one 10 acre soil plot (PT14192) sampled during the 1992 RFI/RI investigation and two untilled Jefferson County Remedy acres plots (U1A and U2A the area for each plot is approximately 10 acres) collected in 1991

Currently the AOCs in IHSS 199 are unused fields and the land has not been developed for recreational uses Although it is possible a current trespasser may be exposed to the surface soil within the AOCs the estimates of risk for future receptors will be much greater than the occasional trespasser who visits the area once or infrequently throughout the year EPA defines the reasonable maximum exposure as "the highest exposure that is reasonably expected to occur at the site " (EPA 1989a) In evaluating future land uses for risk assessment consideration was given to whether future activities are likely to be different than those currently experienced as well as reasonable potential uses Pertinent information, including the municipalities' planning and zoning designs discussed above in Section 2 4 coupled with census projections from the Denver Regional Council of Governments (See Figures 3-1 and 3 2 in TM 2 [DOE 1993a]) all support the assessment that the lands identified in Figure 1 will be used for open space in the future On this basis a recreational land use scenario is identified as the most likely future-use RME scenario In addition the residential scenario will be evaluated in the HHRA for IHSS 199 The residential scenario is assumed to result in the most conservative risk estimates for IHSS 199 The commercial/industrial and ecological research scenarios will not be evaluated quantitatively because it is assumed risks from those scenarios will be less than for the residential scenario

4 1 1 Future Recreational Exposure Scenario

Health risks will be evaluated for a hypothetical future receptor participating in recreational activities within a 50-acre exposure area (CDPHE/EPA/DOE 1994) in the surface soils areas of concern (PT14192, U1A and U2A) Figure 4 shows one possible exposure area for a recreational scenario The placement of the exposure areas is arbitrary the aggregation of data for the estimating of risks will be presented to EPA and CDPHE prior to preparation of the HHRA The recreational exposure scenario assumes a receptor participates in various recreational activities in the OU 3 area (hiking, biking, picnicking, etc) and is exposed to $^{239/240}Pu$ and ^{241}Am in the surface soils in the AOCs The elements of the recreational exposure scenario for surface soil in IHSS 199 are described below and are also summarized in Table 4-1

The HHRA will quantitatively assess the following exposure pathways for exposure to an adult using the exposure area for recreational purposes

- Inadvertent ingestion of surface soil
- Inhalation of airborne soil particulates suspended in air by wind erosion and recreational activities
- External radiation exposure

4 1 2 Future Residential Exposure Scenario

Health risks will be evaluated for a hypothetical future resident within a 10-acre exposure area (CDPHE/EPA/DOE, 1994) in the surface soil AOCs Figure 4 shows one example exposure area for the residential scenario The placement of the exposure areas is arbitrary, the aggregation of data for the estimating of risks will be presented to EPA and CDPHE prior to preparation of the HHRA The HHRA will quantitatively assess the following exposure pathways for a future residential adult

- Inadvertent ingestion of surface soil
- Inhalation of soil particulates suspended in air by wind erosion

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Table 4-1
OU 3 Exposure Scenarios

IHSS	Land Use Assumption	Receptor (s)	Environmental Medium	Exposure Parameter Table No in Appendix A	Exposure Pathway[a]	Evaluation[b c]
IHSS 199 Soils Contamination (Chemicals of Concern = $^{239/240}Pu$ and ^{241}Am)						
	Future Recreational	Adult Recreator	Surface Soil	A 1	Inadvertent ingestion of surface soil	b
				A 2	Inhalation of soil particulates suspended in air by wind erosion & recreational activities	b
				A 3	External radiation exposure	b
					Dermal contact	c
	Future Residential	Adult Resident	Surface Soil	A 1	Inadvertent ingestion of surface soil	b
				A 2	Inhalation of soil particulates suspended in air by wind erosion	b
				A 3	External radiation exposure	b
					Dermal contact	c
				A 4	Ingestion of homegrown produce	b
IHSS 200 Great Western Reservoir (drained[d]) (Chemicals of Concern = $^{239/240}Pu$)						
	Future Recreational	Adult Recreator	Reservoir and Stream Surface Sediments	A 1	Inadvertent ingestion of surface sediment	b
				A 2	Inhalation of sediment particulates suspended in air by wind erosion & recreational activities	b
				A-3	External radiation exposure	b
					Dermal contact	c
	Future Residential	Adult Resident	Reservoir and Stream Surface Sediments	A 1	Inadvertent ingestion of surface sediment	b
				A 2	Inhalation of sediment particulates suspended in air by wind erosion & other activities	b
				A-3	External radiation exposure	b
					Dermal contact	c
				A-4	Ingestion of homegrown produce	b

Table 4-1
OU 3 Exposure Scenarios

IHSS	Land Use Assumption	Receptor (s)	Environmental Medium	Exposure Parameter Table No. In Appendix A	Exposure Pathway[a]	Evaluation[b,c]

Notes:
[a]Both RME and Central Tendency (CT) exposures will be assessed (See Tables A-1, A-2, A 3, and A-4)
[b]Risks will be assessed quantitatively for this exposure pathway
[c]Risks will be assessed qualitatively for this exposure pathway
[d]Exposure scenario assumptions. GWR is drained, no material is added or removed to/from the bottom of the reservoir

- External radiation exposure
- Ingestion of home grown produce

In response to EPA Specific Comment No 3 (Section 4) the HHRA will qualitatively address dermal contact with surface soils and subsequent absorption of COCs

A potential exposure pathway not addressed for IHSS 199 or IHSS 200 is the consumption of meat and dairy products from cattle consuming contaminated feed, water or soil This pathway is not addressed because it is not a complete pathway The average milk or beef cow requires 30 to 70 acres per year of rangeland to sustain including supplemental feed (30% of the diet, more in the winter) (Wyoming Bureau of Land Management, 1994) Using a 10-acre residential exposure area cattle could not be supported Great Western Reservoir or IHSS 199 could not support a residential land use and a rangeland for feeding several cows

The quantitative values of parameters to be assumed for these scenarios and exposure pathways are presented in Appendix A attached to this addendum (Tables A-1 through A-4) Exposure parameters are presented for estimating central tendency (CT) and reasonable maximum exposure (RME) intake for each potentially complete exposure pathway The exposure parameters are reasonable estimates of numerous variables including body weight, daily inhalation volume daily ingestion rates body surface area, soil or food matrix effects and the frequency and duration of exposure Exposure point concentrations, determined by chemical analytical data and fate and transport modeling (described in the Model Selection TM 3) will be used with these exposure parameters and equations to obtain pathway-specific chemical intakes to estimate risks in the HHRA The aggregation of concentration data from samples within the exposure areas will be presented to EPA and CDPHE and for inclusion in the HHRA report

4 2 EXPOSURE SCENARIOS FOR IHSS 200
GREAT WESTERN RESERVOIR SURFACE SEDIMENTS
ASSUMING THE GREAT WESTERN RESERVOIR IS DRAINED

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Currently the reservoir, drainages, and ditches in IHSS 200 have not been developed for residential, industrial, or recreational uses Although it is possible a current trespasser may be exposed to the shoreline surface sediments within the IHSS 200 AOC, the estimates of risk for future receptors will be much greater than the occasional trespasser who currently visits the area once or infrequently throughout the year Therefore, the remaining discussion of the exposure scenarios refer to hypothetical future exposures

By 1997, the City of Broomfield may shift from using the Great Western Reservoir as its water source to using Carter Lake and water purchased from the Denver Water Board Anticipating this action and the potential the reservoir may be drained, a scenario for exposure to $^{239/240}$Pu in Great Western Reservoir surface sediment was developed Great Western Reservoir is assumed drained for recreational, residential, or commercial/industrial uses, thus, exposing the surface sediments in the center of the reservoir Water currently acts as a barrier to human contact and inhibits exposure to humans via suspended particulates in air from wind and other erosion mechanisms Draining the reservoir would remove this barrier, allowing greater contact with surface sediments by potential receptors

The surface sediments in IHSS 200 include the reservoir surface sediments and the North and South Walnut Creek drainage sediments (from Indiana Street into the reservoir) An example of the graphical representation of the exposure areas for the two scenarios that will be quantitatively evaluated in the HHRA (residential and recreational) is shown on Figure 5 The placement of the example exposure areas within Great Western Reservoir on Figure 5 is based on maximum plutonium concentrations at known locations; the aggregation of data for the estimation of risks will be presented to EPA and CDPHE prior to inclusion in the HHRA

4 2 1 Future Recreational Exposure Scenario

The recreational exposure scenario assumes a receptor participates in various recreational activities in the 50-acre recreational exposure area and is exposed to $^{239/240}$Pu in the surface sediments within the exposure area All $^{239/240}$Pu concentration data within the exposure area will be used to calculate an exposure point concentration (discussed in Section 5 0 below) The HHRA will quantitatively assess the following exposure pathways for an adult receptor:

- Inadvertent ingestion of surface sediment

- Inhalation of airborne sediment particulates suspended in air by wind erosion and other recreational activities

- External radiation exposure

The exposure parameters for these exposure pathways are presented in Tables A 1 through A-4 in Appendix A

In response to EPA Specific Comment No 3 (Section 4) the HHRA will qualitatively address dermal contact with surface sediments and subsequent absorption of COCs

4 2 2 Future Residential Exposure Scenario

The residential exposure scenario assumes a resident lives in the 10-acre residential exposure area of IHSS 200 and is exposed to $^{239/240}Pu$ in the surface sediments within the exposure area All $^{239/240}Pu$ concentration data within the exposure area will be used to calculate an exposure point concentration (discussed in Section 5 0 below) The HHRA will quantitatively assess the following exposure pathways for an adult exposure

- Inadvertent ingestion of reservoir and stream surface sediment

- Inhalation of airborne sediment particulates in air suspended by wind erosion and other activities

- External radiation exposure

- Ingestion of homegrown produce

The exposure parameters for these exposure pathways are presented in Tables A-1 through A-4 in Appendix A

In response to EPA specific Comment No 3 (Section 4), the HHRA will qualitatively address dermal contact with surface sediments and subsequent absorption of COCs

SECTION 5 0
ESTIMATING CHEMICAL INTAKES

Chemical intakes are not present in this addendum since they are dependent on exposure point concentrations determined from chemical data and from fate and transport modeling, as appropriate Using the exposure point concentrations of the COCs in IHSS 199 soils and IHSS 200 sediments it is possible to estimate the potential human intake via each exposure pathway described in Section 4 Intake parameters for CT exposure and RME conditions are presented in Appendix A, Tables A-1 through A-4 Intakes are estimated for average CT and RME conditions The RME is estimated by selecting values for exposure variables so that the combination of all variables results in the maximum exposure that can reasonably be expected to occur at the site The CT is estimated by selecting average values for exposure variables

Child intakes are not estimated for any exposure pathway except soil ingestion Exposure to radionuclide COCs will be assessed for the amount taken into the body and the amount of external irradiation

5 1 INTERNAL EXPOSURE TO RADIONUCLIDES

Ingestion or inhalation of radionuclides and their subsequent deposition in receptor tissues or organs will result in a radiation dose to those systems as well as surrounding systems Internal exposure to radionuclide COCs ($^{239/240}$Pu and ^{241}Am) will be assessed in two ways First, using conventional "dose assessment" methods, the committed effective dose equivalent (CEDE) based on intake of radionuclides via ingestion or inhalation will be calculated and compared to radiation protection standards. The CEDE is the summation over specified tissues of the products of the dose equivalent in a tissue or organ and the weighting factor for that tissue over a 50-year period (EPA 1989a) The second method, using conventional "risk assessment" techniques, involves calculating the intake of each radionuclide and multiplying the intake by a EPA-derived carcinogenic slope factor (EPA, 1989a) This calculation results in an estimation of the risk of cancer associated with ingestion or inhalation of a radionuclide Both methods described above are discussed in EPA guidance (1989a)

Intake of radionuclides by ingestion or inhalation is a function of the radionuclide activity, rate of intake (or the amount of contaminated medium contacted per unit time or event), and exposure frequency and duration The intake is an estimate of the total intake of a radionuclide, expressed in units of radioactivity (Curies [Ci])

The intake of radionuclides for both methods is estimated using the following equation

$$Intake = C * IR * EF * ED$$

Where

Intake	=	Internal radionuclide intake via inhalation or ingestion (µCi for dose assessment, pCi for risk assessment)
C	=	Radionuclide activity at the point of exposure (pCi/m^3, µCi/g, pCi/kg)
IR	=	Medium intake rate (the amount of medium taken into the body per unit time) (m^3/day or g/day)
EF	=	Exposure frequency (number of days of exposure per year) and,
ED	=	Exposure duration (1 year for dose assessment, 30 years for risk assessment)

The intake value is then multiplied by either a dose conversion factor or a carcinogenic slope factor to estimate committed effective dose coefficient or carcinogenic risk, respectively The radiation dose is a function of the type of radiation emitted by the radionuclide. The dose equivalent was developed to normalize the unequal biological effects from the different types of radiation Because radiation doses from systematically incorporated radionuclides may continue long after the intake of the nuclide has ceased, doses to specific tissues and organs from internal radionuclides are typically reported in terms of the committed dose equivalent. The committed dose equivalent to specific organs as a result of intake of the radioactive material is estimated by multiplying the intake of each radionuclide by the appropriate dose conversion factor (DCF) The committed dose equivalents for each radionuclide are then summed to obtain a total committed dose equivalent.

The dose conversion factor (DCF expressed in units of millirems [mrem] per μCi) is used to estimate the equivalent dose (in mrem per year) which can then be compared to a radiation protection standard The carcinogenic slope factors for radionuclides of concern are multiplied by the estimated radionuclide intake in total pCi (either inhaled or ingested) to estimate risk (EPA 1989)

The calculated exposure point concentrations, C will be presented to EPA and CDPHE prior to inclusion in the HHRA report.

5 2 EXTERNAL IRRADIATION

External exposure to $^{239/240}Pu$ and ^{241}Am in IHSS 199 soils and Pu-239/240 in IHSS 200 sediments will be assessed in a similar manner as internal radionuclide exposure (i e , dose assessment and risk assessment) External radiation exposure is estimated using the following equation

$$ER = C * 10^3 g/kg * SD * D * (1-Se) * Te * ED$$

Where

ER = External radiation exposure in pCi/m^2 soil/year

C = Activity concentration of a radionuclide at the point of exposure (pCi/g soil or sediment)

SD = Soil density (kg/m^3)

D = Soil depth (m)

Se = Gamma shielding factor (-)

Te = Gamma exposure time factor (-)

ED = Exposure duration (years)

To estimate the EDE for the dose assessment method, radionuclide concentrations on the ground surface (pCi/g), will be multiplied by the external dose conversion factor for specific radionuclides (mrem/yr per μCi/g), and the duration of exposure This will result in a estimate of the effective dose equivalent, which can then be compared to radiation protection standards. For the risk assessment method, the external radiation exposure will be multiplied by the external exposure slope factor (risk/yr per pCi/m^3) to estimate risk.

Aggregation of data within exposure areas to calculate the exposure point concentration, C, will be presented to EPA and CDPHE prior to inclusion in the HHRA report.

SECTION 6 0
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Table A-1
Rocky Flats OU 3 Exposure Parameters for Quantitative Risk Assessment
Soil or Sediment Ingestion

Factors for Potentially Complete Routes of Exposure		Exposure Scenarios: Future Residential	Exposure Scenarios: Future Recreational
Ingestion Rate - Child (mg/day)	RME[1]	200[1],[3]	100[5]
	CT[2]	100[2],[4]	15[5]
Ingestion Rate - Adult (mg/day)	RME	100[6]	50[5]
	CT	50[7]	8[5]
Fraction Ingested from Contaminated Source - Child	RME	1.0[8]	1.0
	CT	0.82[8]	1.0
Fraction Ingested from Contaminated Source - Adult	RME	1.0[8]	1.0
	CT	0.64[8]	1.0
Matrix Effect in GI Tract (Absorption Factor)	RME	Chemical-Specific[9]	Chemical-Specific[9]
	CT	Chemical-Specific[9]	Chemical-Specific[9]
Exposure Frequency - Child and Adult (days/year)	RME	350[10]	25[12]
	CT	234[11]	10[12]
Exposure Duration - Child (years)	RME	6[10]	6[10]
	CT	2[13]	2[13]
Exposure Duration - Adult (years)	RME	24[10]	24[10]
	CT	7[14]	7[14]

Notes

(1) = Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum risks in a baseline or remediation risk assessment RME Risks are derived using professional judgement to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others in combination with others set at Central Tendency (CT) values in order to characterize the HE risks to a very small proportion of an exposed population

(2) = Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk assessment (or a "reasonable worst case" when used in combination with selected high-end values) Average risks are derived using professional judgement to set all exposure parameters at 50th percentile or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population

(3) = EPA RAGS, HHEM Standard Default Exposure Factors (1991a) A defensible alternative HE value for the child is 110 mg/day, the approximate 95th percentile using Zr tracer study of Calabrese and others (1989 1991) (median = 16 mg/day 95% CI = 8-24 mg/day n=128 AIHC 1994) An alternative HE assumption for the adult is 55 mg/day (0 5 times the child rate)

(4) = Preliminary CT default values (EPA, 1993)

(5) = Assumes standard default residential rates as specified for open-space recreational users at DOE's Fernald Site and Hanford Site (RME=200 mg/day for children and 100 mg/day for adults) and the Denver's Lowry Landfill Superfund Site (CT=100 mg/day for children and 50 mg/day for adults) Assumes that Exposure Time is 1 5 hours per day (CT) 5 0 hours per day (RME) and that total soil ingestion occurs over 10 daylight hours (1 5/10 = 0 15 5 0/10 = 0 5) Using the default daily ingestion rates soil ingestion per visit for children is calculated as RME=0 5x200=100 mg/visit CT=0 15x100=51 mg/visit For adults the ingestion rates are RME=50 and CT=8 Actual open space recreational intakes would vary, depending on the activity, possibly with dirt biking at one extreme and photographing wildlife at at the other

(6) = EPA, 1991a

(7) = Assumed to one-half equal residential exposure See (6)

(8) = Based on the average time spent at home (0 64 for an adult and 0 82 for a child) (AIHC, 1994) EPA 1989a recognizes the need for a soil "fraction ingested" from a contaminated source to reflect "population activity patterns "

(9) = In the absence of a chemical-specific value, consult methods to estimate maximum oral bioavailability (absorption in the gastrointestinal tract) such as reported by EPA, 1994b, for lead in soil and by Finley and Paustenbach, 1994 for TCDD in soil Assuming chemical toxicity values are based on absorption from drinking water, absorption adjustments are indicated because toxic chemicals only partially desorb from soil particles (EPA, 1989a)

Y/

(10) = EPA, 1991a

(11) = EPA, 1991a

(12) = Exposure frequency based upon Boulder County s Park and Open Space Visitor Interviews of 1985 (est 7 days/yr, CT, 25 days/yr, RME) DOE's Hanford Site recreational user (7 days/yr, CT) and Department of the Interior's (DOI) National Survey of Fishing, Hunting and Nonconsumptive Wildlife Recreation of 1985 for Colorado (9.4 days/yr for nonconsumptive use, CT, 15 4 days/yr for fishing and hunting, CT)

(13,14) = Preliminary CT default values summing to 9 years (2 years + 7 years) total exposure duration (EPA, 1993) Preliminary CT value (EPA, 1993) A current alternative value is EPA's CT Residential Occupancy Period (ROP) of 8 1 years of total population (EPA, 1992, AIHC, 1994)

Table A-2
Rocky Flats OU 3 Exposure Parameters for Quantitative Risk Assessment
Soil or Sediment Particulate Inhalation

Factors for Potentially Complete Routes of Exposure		Exposure Scenarios: Future Residential	Exposure Scenarios: Future Recreational
Inhalation Rate - Adult (m^3/day)	RME[1]	0 83[1] [3]	1 4[5]
	CT[2]	0 63[2] [4]	0 83[5]
Respirable Fraction PM_{10}	RME	0 46[6]	0 46[6]
	CT	0 36[6]	0 36[6]
Exposure Time Adult (hr/day)	RME	24[3]	5[8]
	CT	15[7]	1 5[8]
Exposure Frequency - Adult (days/year)	RME	350[3]	25[10]
	CT	234[9]	10[10]
Exposure Duration - Adult (years)	RME	30[3]	30[3]
	CT	9[11]	9[11]

Notes

(1) = Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum risks in a baseline or remediation risk assessment RME Risks are derived using professional judgment to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others in combination with others set at Central Tendency (CT) values in order to characterize the HE risks to a ver small proportion of an exposed population

(2) = Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline o remediation risk assessment (or a "reasonable worst case" when used in combination with selected high-end values) Average risks are derived using professional judgment to set all exposure parameters at 50th percentile or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population

(3) = EPA, 1991a

(4) = CT residential inhalation rate for an adult based on EPA, 1991b

(5) = Inhalation Rate based upon DOE's Fernald Site and Hanford Site recreational users (0 83 m^3/hr, CT and on EPA's *Exposure Factors Handbook* (1 4 m^3/hr, RME) which assumes 7% heavy activity, 37% moderate activity 28% light activity, and 28% resting for an adult.

(6) = Based on the five-year (1988-1992) mean annual ratio of PM_{10} soil or dust particles to total suspended particulates (TSP) as reported in 1992 RFP Site Environmental Report, EPA Exposure Factors Handbook (1989b) recognizes that need for a "respirable fraction of particulates" to indicate the total respirable fraction assumed deposited in the lung)i e , 100% of the PM_{10} value)

(7) = Based on the average time spent at home (0 64 for an adult) (AIHC 1994, Gephart, Tell, and Triem 1994)

(8) = Exposure Time based upon Boulder County's Park and Open Space Visit Interviews of 1992 (est 1 6 hr/day, CT, 5 0 hr/day, RME), DOD's Rocky Mountain Arsenal Site recreations user (1 6 hr/day, CT, 5 0 hr/day, RME), and City of Boulder's Open Space Visitation Study for 1993 (1 0 hr/day, CT, 2 0 hr/day, RME)

(9) = Preliminary CT default values (EPA 1993)

(10) = Exposure frequency based on Boulder County's Park and Open Space Visitor interviews of 1985 (estimated 7 days/year CT 25 days/year RME) DOE's Handford Site recreational user (7 days/year, CT) and DOI's National Survey of Fishing Hunting and Nonconsumptive Wildlife Recreation of 1985 for Colorado (9 4 days/year for nonconsumptive use, CT, 15 4 days/year for fishing and hunting, CT)

(11) = Preliminary CT value (EPA 1993) A current alternative value is EPA's CT Residential Occupancy Period (ROP) of 8 1 years of total population (EPA 1992 AIHC 1994)

Table A-3
Rocky Flats OU 3 Exposure Parameters for Quantitative Risk Assessment
External Irradiation

Factors for Potentially Complete Routes of Exposure		Exposure Scenarios: Future Residential	Exposure Scenarios: Future Recreational
Gama Exposure Time Factor	RME[1]	1[1],[3]	0 2[5]
Te	CT[2]	0 75[2],[4]	0 1[5]
Gamma Shielding Factor	RME	0.8[6]	1[6]
1 - Se	CT	0 5[7]	0 8[9]
Exposure Frequency -	RME	350[3]	25[11]
Adult (days/year)	CT	234[10]	10[11]
Exposure Duration -	RME	30[3]	30[3]
Adult (years)	CT	9[12]	9[12]

Notes

(1) = Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum risks in a baseline or remediation risk assessment RME Risks are derived using professional judgement to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others in combination with others set at Central Tendency (CT) values in order to characterize the HE risks to a very small proportion of an exposed population

(2) = Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk assessment (or a "reasonable worst case" when used in combination with selected high-end values) Average risks are derived using professional judgement to set all exposure parameters at 50th percentile or mean values in order to characterize the mid range risk to the largest proportion of an exposed population

(3) = EPA, 1991b

(4) = Assuming the CT fraction of time spent at home (average of adult = 0 64 and child = 0 82) (AIHC 1994 Gephart Tell and Triemer 1994)

(5) = Assuming the HE fraction of time exposed (1 5 out of 24 hours) CT 5 0 out of 24 hours RME)

(6) = Standard default screening value specified in EPA, 1991b (1 - 0 2 = 0 8) assuming substantial time of exposure is shielded by structures

(7) = Estimated typical value for residents and indoor workers shielded by buidlings (DOE documents for RFETS such as Mining Exposure Scenario for Baseline Risk Assessment at the Rocky Flats Environmental Technology Site dated 8/9/94)

(8) = Standard default screening value specified in EPA 1991b, assuming limited exposure time shielded by structures

(9) = Assumed typical value for outdoor workers with only limited shielding indoors

(10) = Preliminary CT default value (EPA 1993)

(11) = Exposure Frequency based upon Boulder County's Park and Open Space Vistor Interviews of 1985 (est 7 days/yr, CT, 25 days/hr RME) DOE's Hanford Site recreational user (7 day/yr CT) and Department of the Interior's (DOI) National Survey of Fishing, Hunting and Nonconsumptive Wildlife Recreation of 1985 for Colorado (9 4 days/yr for nonconsumptive use, CT, 15 4 day/yr for fishing and hunting, CT)

(12) = Preliminary CT value (EPA, 1993). A current alternative value is EPA's CT Residential Occupancy Period (ROP) of 8 1 years of total population (EPA, 1992, AIHC, 1994)

Table A-4
Rocky Flats OU 3 Exposure Parameters for Quantitative Risk Assessment
Homegrown Produce Ingestion

Factors for Potentially Complete Routes of Exposure		Exposure Scenarios: Future Residential	Exposure Scenarios: Future Recreational
Ingestion Rate - Vegetables Adult (mg/day)	RME[1]	200[1] [3]	(NA)
	CT[2]	200[2] [3]	(NA)
Ingestion Rate - Fruits Adult (mg/day)	RME	140[3]	(NA)
	CT	140[3]	(NA)
Fraction Vegetables Ingested from Contaminated Source	RME	0 4[4]	(NA)
	CT	0 25[4]	(NA)
Fraction Fruits Ingested from Contaminated Source	RME	0 3[4]	(NA)
	CT	0 2[4]	(NA)
Washoff Factor	RME	1 0[5]	(NA)
	CT	0 5[5]	(NA)
Exposure Frequency - Adult (days/year)	RME	350[6]	(NA)
	CT	150[7]	(NA)
Exposure Duration - Adult (years)	RME	30[8]	(NA)
	CT	9[9]	(NA)

Notes

(1) = Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum risks in a baseline or remediation risk assessment RME Risks are derived using professional judgement to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others in combination with others set at Central Tendency (CT) values in order to characterize the HE risks to a very small proportion of an exposed population

(2) = Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk assessment (or a "reasonable worst case" when used in combination with selected high-end values) Average risks are derived using professional judgement to set all exposure parameters at 50th percentile or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population

(3) = Average adult vegetable intake and average adult fruit intake (EPA, 1989b)

(4) = The HE and CT fraction ingested (FI) is based on the fraction of fruits and vegetables consumed daily that is *home-grown* (EPA, 1989b)

(5) = It assumed that residents consuming their own howegrown fruits and vegetables also wash off *at least* one-half of all contaminated soil and dust particles adhering to root and leaf vegetables and to fruits.

(6) = EPA, 1991 A conservative exposure frequency would be 215 days (first harvest May 1, last harvest December 1) (Cox, 1994) The default exposure frequency of 350 days/year assumes and additional 135 days consuming preserved home-grown produce

(7) = Based on the typical fraction of the year home-grown produce is harvested on Colorado's Eastern Plains (first harvest May 15, last harvest October 15) (Cox, 1994)

(8) = EPA, 1991a

(9) = Preliminary CT value (EPA, 1993) A current alternative value is EPA's CT Residential Occupancy Period (ROP) of 8 1 years of total population (EPA, 1992, AIHC, 1994)

Response to Comments

Technical Memorandum No 2

Exposure Scenarios

Human Health Risk Assessment

Rocky Flats Environmental Technology Site, Operable Unit No 3

This comment response addresses the comments that EPA and CDPHE expressed in their reviews of the draft Exposure Scenarios Technical Memorandum No 2 (TM 2) Operable Unit 3 (OU 3) (dated April 1993) TM 2 identifies the exposure scenarios for assessment in the OU 3 Human Health Risk Assessment (HHRA) The HHRA will be included in the forthcoming Resource Conservation and Recovery Act (RCRA) Facility Investigation/ Remedial Investigation (RFI/RI) Report The attached Addendum to the Exposure Scenarios TM 2 is a companion document to these responses and should be referred to for additional detail regarding the exposure scenarios

EPA s and CDPHE s comments are presented in **BOLD** and are preceded by "Comment " U S Department of Energy (DOE) responses to comments are preceded by "Response " The comment responses are divided into **General** and **Specific** comment responses for EPA and CDPHE

Responses To EPA Comments

Comment- Section 3, EPA General Comment No 1

The reasonable maximum exposure (RME) scenario is a combination of three elements (1) land use assumption, (2) exposure pathway combinations, and (3) exposure pathway equation parameters that are an appropriate mix of values that reflect averages and 95th percentile values. The discussion of future land use in Technical Memorandum 2 includes a number of different land use scenarios but it is not clear if the RME is a combination of scenarios reflecting different development patterns for distinct parcels of land or if it is DOE's intention to assume one RME scenario across the entire study area This must be clarified The consideration of the use of all environmental media (soil, water, sediment, air) on OU 3 should be consistent with the definition of the RME This is critical because the RME is a basis for the remedial action (or no action) decision (see OSWER Directive 9355 0-30)

Response The Reasonable Maximum Exposure (RME) scenario consists of a combination of land use assumptions and exposure parameters that are a mix of typical values and upperbound (95th percentile) values and is included in the attached Addendum to TM 2 A Central Tendency (CT) scenario is also included that uses average exposure parameter values for the same land uses and exposure pathways only to assess the range of exposures

The attached Addendum to the Exposure Scenarios TM 2 contains additional information regarding the RME and CT scenarios Tables A-1 to A-4 of the Addendum contain the RME and CT exposure parameters to be used in the HHRA.

Comment Section 3, EPA General Comment No 2

The discussion of land uses of IHSSs 200-202 should focus on the use of the water as a resource The likelihood of use of site water as a drinking water supply is a central question in the risk assessment The beneficial use of the water should be determined as well. The text of Technical Memorandum 2 focuses instead on the land surrounding these IHSSs. This should be modified by discussing the water as a resource, its potential uses, and the use associated with the RME exposure scenario The discussion of the future use of Great Western Reservoir should include consideration of the use of the water in the event the reservoir is not permitted to dry up Since the land surrounding GWR is likely to be used for recreation or open space, will the water be used in some compatible manner (i e , boating, fishing, swimming)?

Response It is recognized that the treated surface water in Great Western Reservoir (IHSS 200) and Standley Lake (IHSS 201) is used as a drinking water supply However because no chemicals of concern (COCs) (DOE, 1994a) were identified in surface water for any of the IHSSs, the HHRA will not characterize risks for human receptors using the surface water in IHSSs 200 201 and 202 Therefore it is not necessary to expand the surface water medium discussion for the HHRA.

Comment Section 3, EPA Specific Comment No 1

The following inconsistencies between the text and figures in Section 3 should be corrected:

a. **On figure 3-5, the Walnut Creek drainage east of Great Western Reservoir is shown as commercial/industrial. The text on page 24 states that residential development is projected to increase in this area.**

b **There is no indication of the Jefferson County Airport on figure 3-5 yet the text doesn't mention that the airport will no longer be there**

c **The area south of Church Ditch on the west side of Standley Lake is shown in figure 3-4 as currently developed for residential use Figure 3-5 indicates that future use will be for parks and open space This is inconsistent with the plans for development of Standley Lake by the Standley Lake Task Force**

Response a Although not indicated the land use in Figure 3-5 is classified as a commercial/industrial/residential mix, therefore the statement that residences in this area are expected to increase is correct This figure will be revised for the HHRA to include the residential mix land use classification

b The Jefferson County Airport was not shown specifically on Figure 3-5 because the figure shows land uses based on county and city zoning projections not specific features of the land The land use classification of commercial/industrial mix is used to represent the airport

c The figures will be revised in the HHRA to be consistent with the planned use for the area

Comment Section 3 EPA Specific Comment No 2

Pages 16, 17, and 18 of 30, Sections 3.1.2.4, 3.1.3.4, and 3.1.4.4. It is noted in these sections that water from Mower Reservoir, Standley Lake, and Great Western Reservoir is being used for irrigation of crops used for cattle grazing and horse boarding Alfalfa, wheat, barley, corn, and oats are also being produced in this area for consumption If water is being directly drawn from these sources and used for irrigation purposes, contaminants could be taken up into plants and humans could be exposed either through direct ingestion of crops, or ingestion of dairy products or meat Although it is noted that the water from these sources meets federal and state drinking water standards, the information is irrelevant in a risk assessment Because radionuclides and heavy metals are sequestered in sediments, surface water samplings should duplicate the conditions of possible exposures. This will likely involve the resuspension of contaminated sediments.

Response In response to EPA s concern that surface water sampling should duplicate the conditions of possible exposure the OU 3 RFI/RI sampling efforts adequately characterize sediments and surface water All water samples were collected for total and dissolved metals The analysis of total metals includes the resuspended sediments present in the water

column Samples were collected from near shore exposed sediments and core sample sediments from the reservoir bottom In addition, grab sediment samples were collected from the reservoir bottoms Because COCs were not identified in surface water for any of the IHSSs (DOE 1994a) the irrigation pathway does not need to be assessed for inclusion in the HHRA

Comment Section 3, EPA Specific Comment No 3

Page 17 of 30, Section 3.1.3. It is noted in these sections that many recreational activities take place at Standley Lake The risk assessment must include ingestion of locally caught fish as well as ingestion of surface water and sediment while swimming, and dermal contact with surface water and sediment

Response Because no COCs were identified for surface water and sediment in Standley Lake (IHSS 201) (DOE 1994a), the HHRA will not characterize risks for human receptors ingesting fish from IHSS 201 Therefore it is not necessary to expand the discussion of ingestion of locally caught fish for the HHRA Additionally Standley Lake is stocked with subadult fish for recreational fisherman. These game fish receive most of their diet from near the surface of the water and do not routinely contact the sediment thereby, minimizing exposure to humans ingesting fish

Comment Section 4, EPA General Comment No. 1

Exposure pathways were eliminated from further consideration without adequate justification. As an example, the justification provided for the exclusion of ingestion of leafy vegetables is contradictory On page 10, it is acknowledged that this pathway contributed the greatest risk in a residential exposure scenario according to the Past Remedy Report. This indicates the importance of reassessing the risk using OU 3 Remedial Investigation (RI) data. As another example, the results of the Historical Information Summary and Preliminary Health Risk Assessment Report (HISPHRA) are not considered to be adequate justification primarily because this document only considered exposure to plutonium. The OU 3 RI program includes sampling and analysis for TAL metals, a limited number of pesticides, volatiles, uranium, and americium in surface water and sediment. These substances differ from plutonium in key physical and chemical parameters. Therefore, the HISPHRA is not adequate justification for eliminating exposure pathways.

Response Potential land uses and associated exposure pathways have been refined based on the COCs (DOE 1994a) identified for OU 3 These land uses/ exposure pathways are described in the Addendum to TM 2 and include the following

Residential Land Use (IHSSs 199 and 200)

- Ingestion of surface soil/surface sediment
- Inhalation of particulates
- Dermal contact with surface soil/surface sediment
- External radiation
- Ingestion of fruits and leafy vegetables

Recreational Land Use (IHSSs 199 and 200)

- Ingestion of surface soil/surface sediment
- Inhalation of particulates
- External radiation
- Dermal contact with surface soil/surface sediment

Ecological Research Land Use (IHSSs 199 and 200)

- Ingestion of surface soil/surface sediment
- Inhalation of particulates
- Dermal contact with surface soil/surface sediment
- External radiation

Commercial/Industrial Land Use (IHSSs and 199 and 200)

- Ingestion of surface soil/surface sediment
- Inhalation of particulates
- Dermal contact with surface soil/surface sediment
- External radiation

This list is based on the COCs (DOE 1994a) that were identified for OU 3 Exposure pathways were included only for those media with COCs

The most likely land use for IHSSs 199 and 200 is recreational, and therefore this scenario will be quantitatively evaluated in the HHRA In addition the land use associated with the most conservative estimates of risk (i e residential) will also be quantitatively evaluated in the

55

HHRA The commercial/industrial worker and ecological researcher scenarios will not be quantitatively evaluated in the HHRA However it is assumed risks for those two scenarios will be less than risks associated with the residential scenario The HHRA will include a qualitative discussion of the dermal exposure pathway for the residential and recreational exposure scenarios

Comment Section 4, EPA General Comment No. 2

The elimination of exposure pathways from consideration based on a comparison on non-RI data to potential ARARs (e.g., discussion on page 18 regarding the ingestion of surface water) is inconsistent with the National Contingency Plan The preamble on page 8709 states, "The identification of ARARs is not the purpose of the baseline risk assessment. The identification of ARARs is a separate part of the RI, because many ARARs are not directly risk related. ARARs generally do not provide an adequate basis on which to determine site risks, which are complex and often cannot be reduced to a single number because these standards are established on a national basis, they may not adequately consider the site specific contamination or the cumulative effect of the presence of multiple exposure pathways and, therefore, are not the sole determinant of protectiveness."

Response ARARs were not used to eliminate exposure pathways. Exposure pathways have been eliminated (e g ingestion of surface water) based on the COCs (DOE, 1994a) identified for OU 3

Comment: Section 4, EPA Specific Comment No. 1

<u>Page 7 of 37, Section 4.4.1</u>. Ingestion of homegrown fruits, vegetables and beef should be included in the risk assessment for several reasons. First, as it noted in the discussion of land use, considerable areas in OU 3 are not only zoned agricultural, but are currently being used for this purpose Crop production and grazing are the main activities. Moreover, the area is being irrigated for crop production with surface water from OU 3, which may or may not be contaminated. Second, reference to "limited use" of home gardens indicates that residents are currently ingesting homegrown vegetables, suggesting this is a complete pathway Third, although it is correct that radionuclides are not readily taken up by plants, heavy metals are For these reasons, these pathways should be included in the risk assessment and at least qualitatively discussed.

Response The agricultural land use scenario was considered However based on the identified AOCs (DOE 1994b) and the deed restrictions and zoning in the AOCs an agricultural land use scenario is not expected for IHSS 199 A residential exposure scenario including ingestion of fruits and vegetables has been identified for Great Western Reservoir because of the uncertainty associated with the future use of this reservoir In addition the residential scenario including ingestion fruits and vegetables will be evaluated for IHSS 199

Comment Section 4, EPA Specific Comment No 2

Page 23 of 37, Section 4.4.4 The rationale presented for not considering the exposure of office workers quantitatively is unacceptable and is inconsistent with previous Rocky Flats human health technical memoranda for OU 1 and OU 2 Furthermore, it conflicts with EPA guidance in OSWER Directive 9285 6-03, Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors " The exposure of future office workers to contaminants within OU 3 must be quantitatively evaluated

Response The most likely land use for IHSSs 199 and 200 is recreational and therefore this scenario will be quantitatively evaluated in the HHRA In addition the land use associated with the most conservative estimates of risk (i e residential) will also be quantitatively evaluated in the HHRA The commercial/industrial worker and ecological researcher scenarios will not be quantitatively evaluated in the HHRA However it is assumed risks for those two scenarios will be less than risks associated with the residential scenario

Comment Section 4, EPA Specific Comment No 3

Include the following exposure pathways in the quantitative baseline risk assessment for OU 3

Residential Scenario.

Ingestion of homegrown fruits
Ingestion of leafy vegetables
Ingestion of homegrown meat products
***Dermal contact with surface water and sediment**
Ingestion of surface water
Ingestion of surface water while swimming

Ingestion of sediment while swimming
Ingestion of locally caught fish

Recreation Scenario.

Ingestion of surface water
***Dermal contact with surface water**
***Dermal contact with sediment**
Ingestion of sediment while swimming
Ingestion of locally caught fish

Commercial/Industrial Scenario (office worker

Inhalation of particulates
Soil ingestion

***Pathways may be assessed qualitatively Although they are complete, it is likely that relative to other pathways, they present low risk.**

Response The potential exposure pathways for OU 3 based on identification of COCs (DOE, 1994a) are listed in the response to Section 4 EPA General Comment No 1 The exposure scenarios that will be quantitatively evaluated in the HHRA are also described in the response

Comment: Section 5, EPA Specific Comments 1-7

1 **Table 5-1, Inhalation of Particulates, Residential Scenario. An inhalation rate of 0.83 cubic meter/hour (cu m/hr) is used as the reasonable maximum exposure (RME) inhalation rate for adults. However, 1.25 cu m/hr is the upper bound value Use of a deposition factor is inappropriate**

2. **Tables 5-2 and 5-3, Soil Ingestion, Residential and Commercial/Industrial Scenario. A matrix effect factor should not be used unless site-specific information is available. The averaging time for non-carcinogens should be equal to the exposure duration.**

3 **Table 5-4, Particulate Inhalation, Construction Worker An inhalation rate of 1.67 cu m/hr should be used. The noncarcinogenic averaging time of 25 years should be changed to**

1 year The use of a deposition factor is inappropriate for the commercial worker Deposition factors are taken into account during the development of the RfC or inhalation slope factor when pharmacokinetic data is present

4 Table 5 5, Soil Ingestion, Recreational Scenario The soil ingestion rate of 25 milligram/event (mg/event) for children and 50 mg/event for adults should be changed to 200 and 100 milligram/day (mg/day) for children and adults, respectively The matrix effect factor should be eliminated The exposure frequency listed in the table should be changed to 100 days/year The exposure duration should be 30 years The noncarcinogenic averaging time should be 30 years

5 Table 5-6, Ingestion of Sediments, Recreational Scenario Ingestion of sediments should be included along with surface water The matrix effect factor should be deleted from the analysis An exposure duration of 30 years should be used Exposure via ingestion of sediments should also be quantified for adults to be consistent with the rest of the recreational scenarios

6 Table 5-7, Ingestion of Surface Water, Recreational Scenario An exposure frequency of 7 events/year should be used The exposure duration should be 30 years.

7 Table 5-8, Inhalation of Particulates, Recreational Scenario It is unnecessary to evaluate children separately An exposure time of 3 hours/day should be used. An exposure frequency of 100 days/year should be used A deposition factor should not be included

Response Table 2 in the attached Addendum to the Exposure Scenario TM 2 presents the exposure scenarios and exposure pathways for evaluation in the OU 3 HHRA The exposure parameters for use in the HHRA are presented in Appendix A of the Addendum Both upperbound exposure parameters (used to characterize the RME scenario in a baseline risk assessment) and CT exposure parameters (used to characterize the typical case) will be used in the HHRA to assess the range of potential exposures

Responses To CDPHE Comments

Comment CDPHE Comment No 1

Section 2.2. The second paragraph in this section misinterprets the purpose of the OU 3 investigations These investigations are to assess the risk of exposure to potential

contamination within OU 3 Regardless of where this contamination may have originated, the contaminated media in OU 3 are now themselves considered potential sources of contamination. In addition, statements the "RFP is no longer a source of contamination," and "current operations at the RFP meet all state and federal standards," are incorrect

Response The second paragraph in Section 2 2 differentiates OU 3 from the other OUs in that no operations were conducted in OU 3 - any contamination in OU 3 is a result of environmental transport from Rocky Flats The risk of exposure will be assessed for chemicals found at concentrations exceeding background levels (DOE, 1994a, CDPHE/EPA/DOE, 1994, DOE, 1993)

The second sentence ("RFP is no longer a source of contamination.. ") will be deleted from this paragraph However there are no known sources currently contributing contamination to OU 3

The statement "current operations at the RFP meet all state and federal standards" should read "the current operations at the RFETS meet all state and federal *emissions* standards "

Comment: CDPHE Comment No. 2

Section 3.0: It is unclear why populations in Sectors 2 and 3 are not projected to increase in Table 1 and in Figures 2 and 3 Sections 3.2.1 1, 3.2.3 1, and 3.2.4.1 all mention potential residential development just east of Indiana Street.

Response Sector 2 falls within the RFETS boundary and the population is not expected to change within these sectors However east of Indiana Street, the population in Sectors 3 and higher are projected to increase

Comment: CDPHE Comment No. 3

Section 3.1.1.4. More detail should be provided on the gardening habits of residents who live in agricultural settings before dismissal of this potential exposure pathway

Response See Response to Section 4, EPA Specific Comment No 1

Comment CDPHE Comment No 4

Section 3 1 4.4 Since "Mower Reservoir water is used to irrigate the pasture land and water the livestock of the farmer who owns it," a current agricultural use scenario should be assessed if the homegrown beef makes up a significant portion of this farmer's diet If so, this possibility needs to be researched, and the intake calculations performed

Response The potential exposure pathways related to agricultural use were considered However based on the identification of COCs (DOE 1994a) no COCs were identified for surface water or sediment in Mower Reservoir Therefore the exposure pathway is not complete and will not be assessed

Comment CDPHE Comment No 5

Section 3.2.1.4 To assess the probability of future agricultural land use, DOE has relied on county zoning projections and appears not to have consulted current land owners. For example, Bini Abbott and her husband intend to continue farming, and their daughter may continue after they retire

Response The fruit and vegetable ingestion pathway will be evaluated for IHSSs 199 and 200 under the residential scenario

Comment CDPHE Comment No 6

Section 3.2.2.3 The Future/Open Space Land Use scenario should also consider dermal contact with water and sediment occurring during activities such as swimming, boating, and hiking

Response The HHRA will include a qualitative discussion of the dermal exposure pathway for contact with surface sediment in Great Western Reservoir for the recreational and residential exposure scenarios No COCs were identified for sediments and surface water in Standley Lake and Mower Reservoir or in surface water in Great Western Reservoir (DOE 1994a) Therefore there is not a complete exposure pathway for dermal contact with surface water and sediments in Standley Lake and Mower Reservoir or for surface water in Great Western Reservoir

Comment: CDPHE Comment No 7

Section 4.2.1: References should be cited for the discussion on page 8 of Section 4 of deposition of radionuclides on foliar surfaces, root uptake of radionuclides, and cumulative uptake rates. Oxidized forms of plutonium can solubilize to a limited extent and can be absorbed, particularly by the roots of crops (Garland et al , 1981, J. Agric Food Chem 29:915-920) The stems and leaves in general have lower concentrations of plutonium than the roots, but higher concentrations of soluble plutonium (ATSDR Toxicological profile for Plutonium, Dec. 1990), indicating some mobility in plants, though Adriano et al. (Transuranic elements in the environment, Ed: W Hanson, Tech Info. Center, USDOE/TIC-22800, 1980) reported that peeling of potatoes and beets removed 99% of the residual plutonium Plutonium concentrations were higher in the foliage biomass than in the fruits of vegetable crops grown at Oak Ridge and higher in grain crops grown at the Savannah River Plant than in control crops (ATSDR Toxicological profile for Plutonium, Dec. 1990) Sullivan et al. (1980) (referenced in ATSDR Toxicological profile for Plutonium, Dec. 1990) reported that rodents absorbed more PU^{238} when it was incorporated into alfalfa grown on soil containing plutonium than when it was administered in the inorganic form Thus organically-bound plutonium may be more bioavailable than inorganic plutonium. For these reasons, root uptake of radionuclides by plants and the potential risks (however small) of subsequent ingestion of these plants by humans should be evaluated

Response A more detailed discussion of the physical and chemical properties affecting environmental fate and transport of radionuclides will be included in the HHRA report See response to Section 4, EPA Specific Comment No 1 for a discussion of the fruit and vegetable ingestion pathway

Comment: CDPHE Comment No. 8

Section 4.2.1 It is not clear why ingestion of homegrown leafy vegetables would be eliminated as a pathway for the future residential scenario when this pathway contributed the greatest risk at a set soil concentration of 1 pCi/g in the Final Past Remedy Report Because it was the major pathway, elimination of this pathway does not seem justified, even given the arguments that plutonium does bioconcentrate or is not taken up by plants to any great extent Moreover, simply because not many gardens exist in OU 3 now, does not imply that the intake of garden produce in the future should not be assessed.

Response The fruit and vegetable ingestion pathway will be evaluated for IHSSs 199 and 200 under the residential scenario

Comment: CDPHE Comment No 9

Section 4 2 2 In the middle of page 16 of Section 4, "Subsection 4 1 1 1" is referenced, but no such section exists in this technical memorandum

Response The reference to "Subsection 4 1 1 1" should be changed to "4 2 1 "

Comment: CDPHE Comment No 10

Section 4 2.2. Dermal exposure to sediments and surface water are shown as potential pathways in Figures 4-3 and 4-4, these pathways should be assessed

Response See Response to CDPHE Comment No 6

Comment: CDPHE Comment No 11

Section 4.2.3 This paragraph should state that the exposure to external radiation pathway will be assessed

Response Exposure to external radiation will be assessed quantitatively in the HHRA

Comment: CDPHE Comment No 12

Section 4.3.4. The impacts of Rocky Flats on the existing small cattle herds and their owners should be assessed DOE needs to provide evidence that the owners of these herds do not eat a significant amount of homegrown beef before dismissing this possibility

Response Currently no cattle herds exist in the AOCs just east of Indiana Street Based on deed restrictions and the most likely anticipated future use (i e recreational) no cattle herds are expected to exist in the AOCs Local residents will be interviewed concerning number of cattle in the area and the sources of feed for the cattle (i e local vegetation or commercially-supplied feed) to verify eliminating the homegrown beef ingestion pathway from the HHRA

Comment CDPHE Comment No 13

Section 4.4.4. In addition, the office worker receptor should not be eliminated since that receptor provides a way to look at long-term exposures. Office workers should be assessed for inhalation of suspended soil particles in air, external radiation, and ingestion of soil and indoor dust

Response See Response to Section 4, EPA Specific Comment No 2

Comment CDPHE Comment No. 14

Section 4.4.7 The definition of a family farm is too limiting Because a farmer is not totally self-sufficient does not mean that he and his family do not get exposed at all. These people will want to know the risk from Rocky Flats because of their proximity to the plant.

Response The fruit and vegetable ingestion pathway will be quantitatively evaluated in the HHRA under the residential scenario Also see Response to CDPHE Comment No 12

Comment CDPHE Comment No. 15

Section 4.5.2: The possibly that the reservoir will be drained and be developed or used for recreational purposes means that inhalation, ingestion, and direct dermal contact with deeper sediments as well as surface sediments should be assessed for the future residential and future commercial/industrial scenarios. Since building construction is possible, a construction worker scenario should be assessed. If the reservoir is not drained, dermal contact with water and sediments would become a viable pathway

Response: The potential exposure pathways initially under consideration are included in the Response to Section 4, EPA General Comment No 1 Based on the identification of COCs (DOE, 1994a) and the uncertainty associated with the future use of Great Western Reservoir exposures to surface sediments by a resident or recreator in the drained Great Western Reservoir will be assessed in the HHRA. No COCs were identified for subsurface sediments in Great Western Reservoir using a PRG screen based on a construction scenario (DOE, 1994a) In addition, no COCs were identified for surface water for Great Western Reservoir (DOE, 1994a)

Comment· CDPHE Comment No 16

Section 4.5 4 Direct dermal contact with sediments should be included in the future commercial/industrial scenario

Response The HHRA will include a qualitative discussion of the dermal exposure pathway for contact with surface sediment in Great Western Reservoir for the recreational and residential exposure scenarios

Comment· CDPHE Comment No 17

Sections 4.5.5 and 4.5.6 Direct dermal contact with water and sediments should be assessed for current and future recreational exposure scenarios

Response See Response to CDPHE Comment No 6

Comment· CDPHE Comment No 18

Section 4.6 Direct dermal contact with water and sediments should be included in current and future residential and recreational scenarios and in the future commercial/industrial scenario

Response See Response to CDPHE Comment No 16 Dermal contact with surface water will not be evaluated in the HHRA because no COCs were identified for surface water in any of the IHSSs (DOE 1994a)

Comment· CDPHE Comment No 19

Section 4.6.7 See Comment No 24 on agricultural scenario above

Response See Response to CDPHE Comment No 14

Comment· CDPHE Comment No 20

Section 5.2: The final sentence on page 5 should refer to Tables 5-1 through 5-8

Response The reference to Tables 4-1 through 4-8 should be changed to Tables 5-1 to 5-8 The exposure parameter information contained in these tables is now included in Tables A-1 to A-4 of the Addendum to the Exposure Scenarios TM 2

Comment: CDPHE Comment No. 21

Tables 5-1, 5-2, and 5-8: The assumption in these tables that 25% of inhaled particles are deposited in the lungs per se is true However, deposition can also occur in other parts of the respiratory tract and exert health effects. Moreover, the same table in the same study that the 25% figure came from also states that 50% of inhaled particles are deposited in the upper respiratory passages and are subsequently swallowed and retained by the body (EPA, 1985) Because baseline risk assessments are concerned with overall health effects of inhalation and not simply lung effects, the usual value used for depositional fraction is 75%. A wide variety of sources indicate that 25% is too low a value for depositional fraction These include the soil dust inhalation estimates of Hawley (Risk Analysis 5:(4) 289-302, 1985), The International Commission on Radiological Protection (ICRP, 1980) study which states that for aerosols with a mean aerodynamic diameter between 0.2 um and 20 um, the sum of the fractions deposited in the three regions of the respiratory tract varies from about 60% to 90%, and the USEPA's second addendum to air quality criteria for particulate matter and sulfur oxides (EPA/600/8-86-020f, 1982) If applied at all, a value of 75% is recommended.

Response One-hundred percent of the respirable fraction (PM_{10}) is assumed to be deposited in the lung The five-year (1988-1992) mean annual ratio of PM_{10} soil or dust particles to total suspended particles (TSP) is 0 36 the maximum ratio of PM_{10} to TSP is 0.46 (1992 RFP Site Environment Report, DOE, 1992). These values will be used to calculate exposure point concentrations for the inhalation pathway (0 36 for the CT and 0 46 for the RME) See Table A-2 in the Addendum to the Exposure Scenarios TM 2

Comment: CDPHE Comment No. 22

Tables 5-5 and 5-6. The body weight listed in this table is inappropriate for 7 to 18-year old children and adolescents. The mean weight recommended for this age group (males) in EPA's Exposure Factors Handbook is between 23 and 65 kg. It is not clear why DOE decided to assess the 7 to 18-year-old age group for sediment ingestion using a soil ingestion rate that is more appropriate for young children It is also not clear why younger children (< 7 years) are not being assessed, since this group is the one with the hand-to-mouth behaviors that contribute to its designation as a sensitive population, and since it is questionable whether many 18-year olds spend a lot of time playing in creeks where they would be exposed to sediments. Simply because younger children are generally under the supervision of older

people does not mean that they would not play in sediments or shallow water DOE should assess the exposure rate for young children (< 6 years), and should use the appropriate ingestion and dermal contact rates for that age range

Response The body weight for adolescents has been revised based on standard U S EPA guidance Tables A-1 to A-4 of the Addendum to the Exposure Scenarios TM 2 contain the exposure parameters for each potential exposure pathway The sediment ingestion rate while not indicative of adolescent activity patterns was chosen as a conservative upper bound estimate The value may be adjusted to account for activity patterns more specific to that age group Adolescents were selected because of their mobility and independent activity outside of their place of residence Thus they would constitute the most viable population for potential exposure However the age group of 0 to 6 years will be evaluated relative to inadvertent ingestion of soil and surface sediment This will require the assumption that a resident uses the drainages for recreational purposes and allows infants and small children access to those recreational opportunities

Comment CDPHE Comment No 23

<u>Table 5-8</u> Please describe the activity assumptions that were made to calculate the RME inhalation rate for a child in this table

Response A RME inhalation rate for an adult of 0 83 m^3/hr and a CT inhalation rate of 0 63 m^3/hr will be used in the HHRA to address the inhalation exposure pathway These rates are based on moderate activity levels (EPA, 1991a and 1991b) See Appendix A, Table A-2 of the Addendum to the Exposure Scenarios TM 2 for additional information

References

CDPHE/EPA/DOE 1994. Presentation on the Conservative Screen Process for Identification of Source Areas and Data Aggregation for Calculation of Exposure Point Concentrations June 3 1994

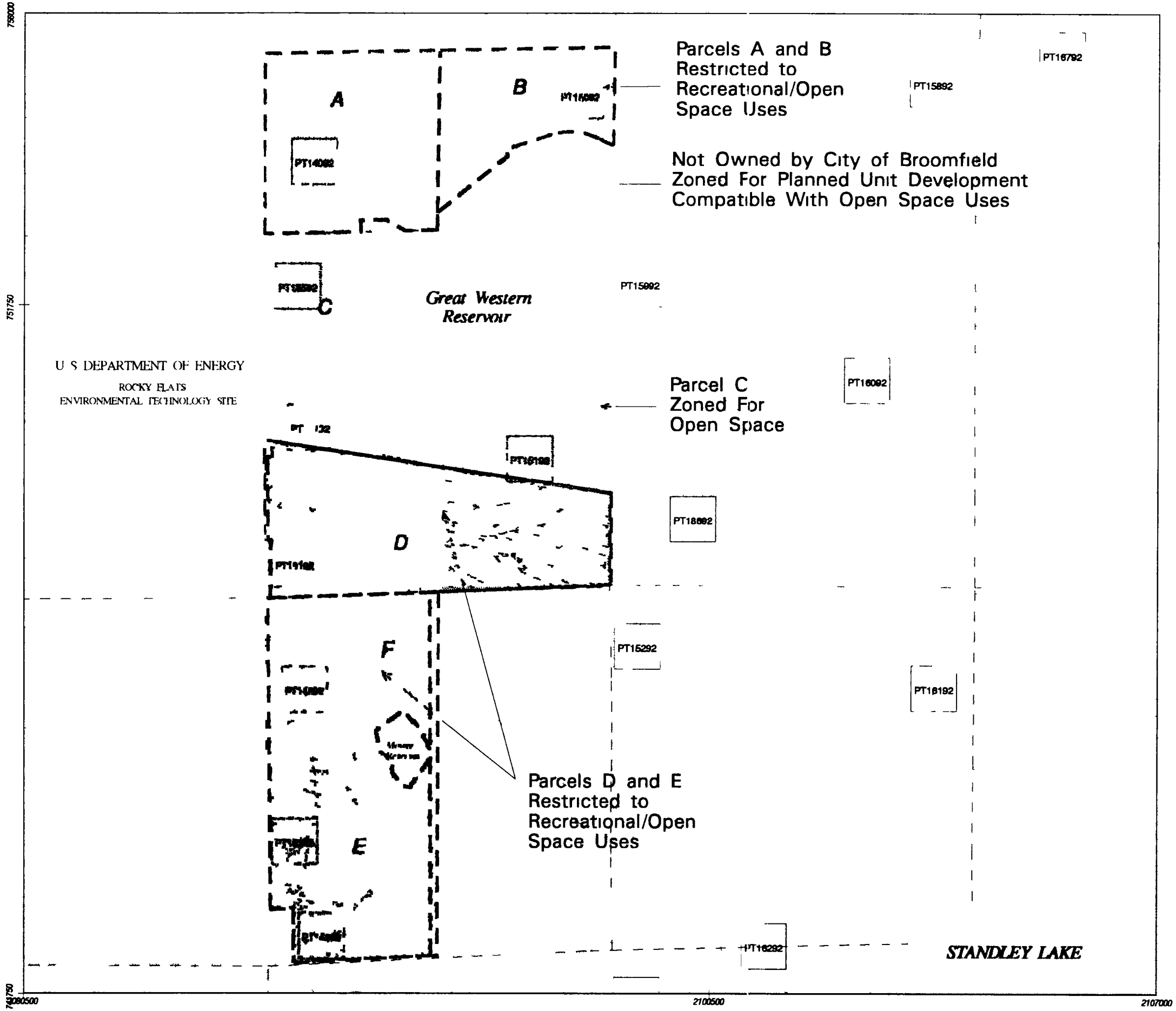
DOE 1993 United States Department of Energy Guidance for Conducting Statistical Comparison of RFI/RI Data and Background Data at the Rocky Flats Plant. Rocky Flats Plant Environmental Restoration Program Golden, Colorado November 30 1993

DOE. 1994a United States Department of Energy Technical Memorandum No. 4. Human Health Risk Assessment. Chemicals of Concern Identification. Operable Unit 3 Rocky Flats Environmental Technology Site Environmental Restoration Program Golden, Colorado September 1994.

DOE. 1994 United States Department of Energy Letter Report Colorado Department of Public Health and Environment Conservative Screen to Define Areas of Concern at Operable Unit 3. Rocky Flats Environmental Technology Site. Environmental Restoration Program Golden, Colorado September 1994.

EPA. 1991a. United States Environmental Protection Agency "Supplemental Guidance to RAGS. Standard Default Exposure Factors (Interim Final) " OSWER Directive 9285.6-03

EPA. 1991b United States Environmental Protection Agency Risk Assessment Guidance for Superfund. Volume 1. Part B-Development of Risk-base Preliminary Remediation Goals. OSWER Directive 9285 7-01B



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ARC NAME /PROJ/OU3/PLOTS/TM2/DEEDRESTR.AML
DRAWN BY D Moreno
APPROVED BY J Reynolds
March 06 1996

Figure 1
Lands Controlled Through Zoning and Deed Restrictions

OPERABLE UNIT 3
ROCKY FLATS
ENVIRONMENTAL TECHNOLOGY SITE
U S Department of Energy

A,B,D E F — Deed restriction parcel boundaries

Zoning	Current Land Ownership
Recreation / Open Space	City of Broomfield
	Jefferson County
Planned Unit Development	Not owned by municipalities or Jefferson County

RFI/RI soil trench

RFI/RI soil sample plot

Jefferson County Remedy Acres

Deed Information

A Owned by the City of Broomfield Deed July 8 1985 between the Great Western Venture and the City of Broomfield. Parcel 2 Reception No 85063451
B Owned by the City of Broomfield Deed July 8 1985 between the Great Western Venture and the City of Broomfield. Parcel 1 Reception No 85063451
C Owned by the City of Broomfield. No Explicit Deed Restrictions
D Owned by Jefferson County Deed July 8 1985 between Butler Investments Ltd William C Ackard and the County of Jefferson State of Colorado Reception No 85063459
E Owned by Jefferson County Deed July 9 1985 between Perry B McKay Charles C McKay First Interstate Bank of Denver and the County of Jefferson, State of Colorado Reception No 85063464.
F Proposed 1994 Agreement between County of Jefferson and City of Westminster

Mapping Sources:
Jefferson County Mapping Dept
EG&G Rocky Flats
U.S Geological Survey
CH2M HILL, Inc

Scale 1 18000
1 in = 1500 ft
500 1000 2000
SCALE FEET

Polyconic projection. 1927 North American datum.
Colorado central zone state plane coordinate system

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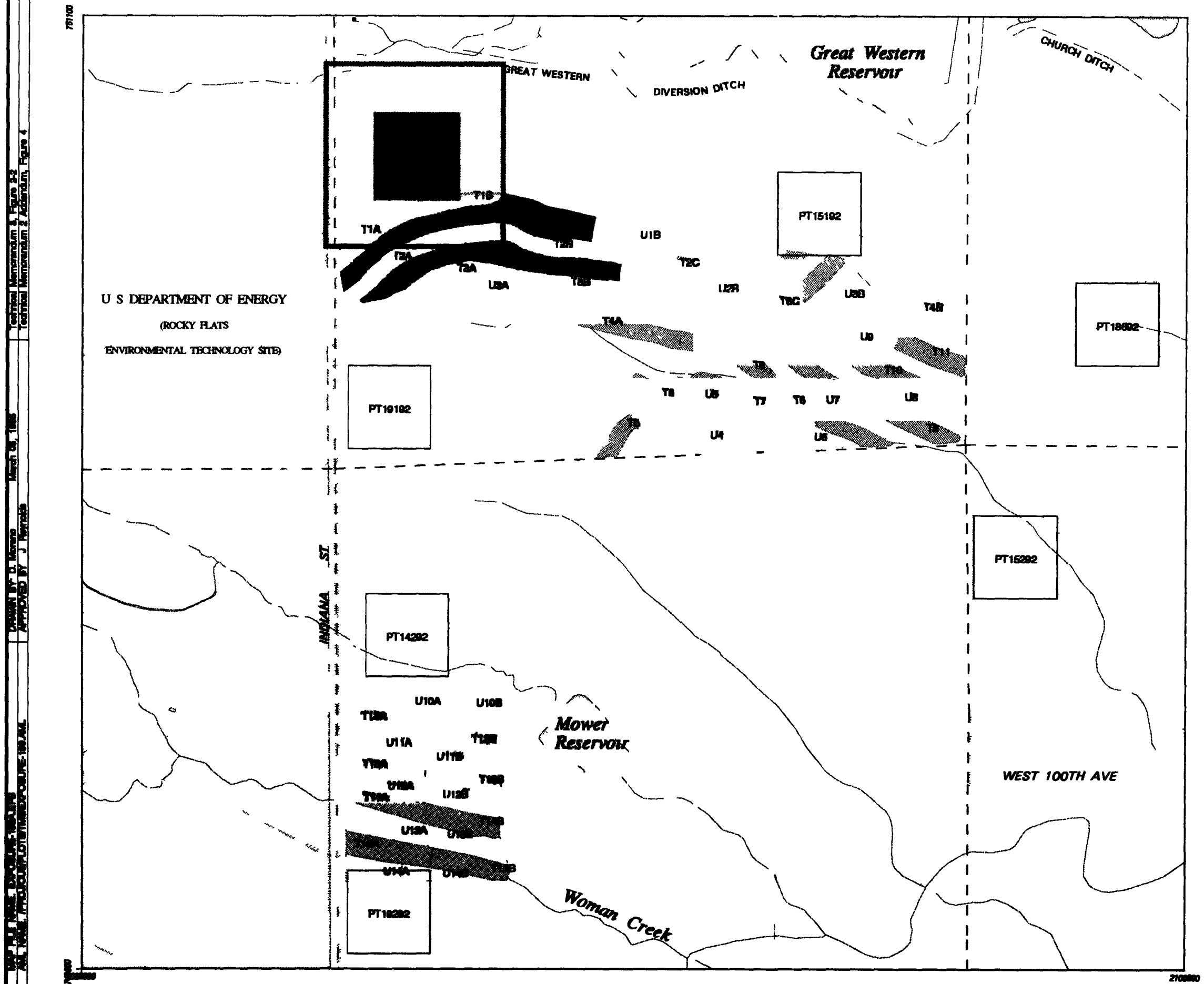

Figure 4
Example Exposure Areas

OPERABLE UNIT 3
IHSS 199 Surface Soil Sampling Area
ROCKY FLATS
ENVIRONMENTAL TECHNOLOGY SITE
U S Department of Energy

Example Exposure Areas
- Recreational Scenario (50 acres)
- Residential Scenario (10 acres)
- Area of Concern
- RFI/RI soil trench
- RFI/RI soil sample plot
- untilled / tilled — Jefferson County Remedy Acres

Note: Areas of Concern were identified in the Letter Report, Colorado Department of Public Health and Environment Conservative Screen to define Areas of Concern at Operable Unit 3 (DOE, Sept. 23, 1994). Areas of Concern are defined as one or more Source Areas grouped spatially in close proximity and exceeding risk-based criteria defined in the CDPHE Conservative Screen. Source Areas are defined as all sample locations where chemical concentrations exceed background levels.

Mapping Sources:
Jefferson County Mapping Dept
EG&G Rocky Flats
U.S. Geological Survey
CH2M HILL, Inc.

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Polyconic projection. 1927 North American datum.
Colorado central zone state plane coordinate system.

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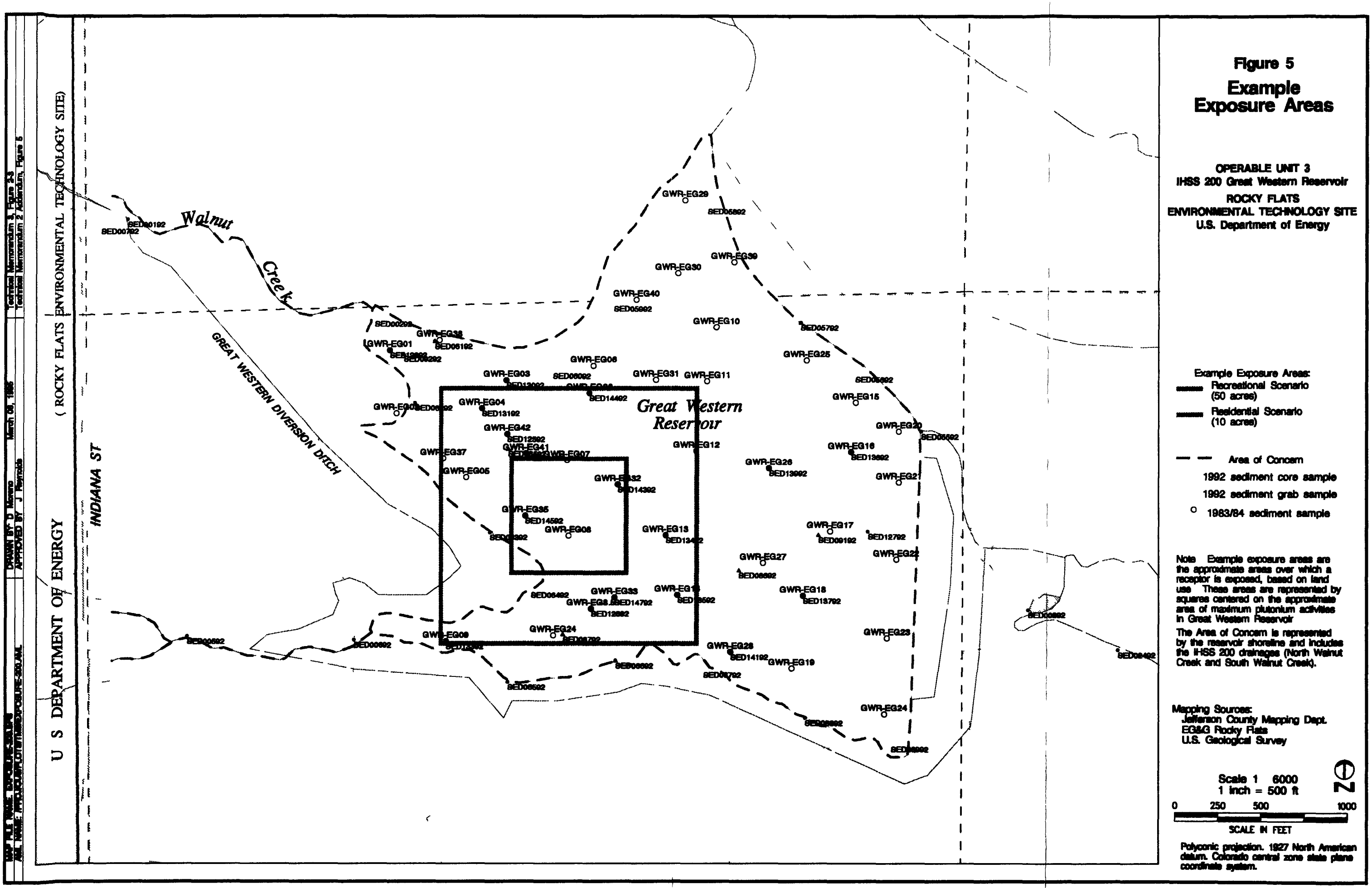

Figure 5

Example Exposure Areas

OPERABLE UNIT 3
IHSS 200 Great Western Reservoir
ROCKY FLATS
ENVIRONMENTAL TECHNOLOGY SITE
U.S. Department of Energy

Example Exposure Areas:
- Recreational Scenario (50 acres)
- Residential Scenario (10 acres)

- Area of Concern
- 1992 sediment core sample
- 1992 sediment grab sample
- 1983/84 sediment sample

Note Example exposure areas are the approximate areas over which a receptor is exposed, based on land use These areas are represented by squares centered on the approximate area of maximum plutonium activities in Great Western Reservoir

The Area of Concern is represented by the reservoir shoreline and includes the IHSS 200 drainages (North Walnut Creek and South Walnut Creek).

Mapping Sources:
Jefferson County Mapping Dept.
EG&G Rocky Flats
U.S. Geological Survey

Scale 1 6000
1 inch = 500 ft

0 250 500 1000
SCALE IN FEET

Polyconic projection. 1927 North American datum. Colorado central zone state plane coordinate system.